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PARADOX. BY G. SHAW, KEMBLE, ONT., CANADA.—Suppose $a = b$. Multiply both sides of this equality by b, and we have $ab = b^2$. Subtract a^2 from each side of this equation and we have $ab - a^2 = b^2 - a^2$. . . (1) By factoring (1) we have $(b - a)a = (b - a)(b + a)$. Divide this eqn. by $b - a$ and we have $a = b + a$ or, because $b = a$,

$$a = a + a = 2a.$$

Dividing by a we have $1 = 2$.

[The fallacy in the above obviously consists in considering a and b as *like* and *unlike* at the same time. For, in the first member of (1) because $a=b$, we have a zero factor, $b - a = 0$, and in the second member we have the same zero factor, $b - a$. Now when a and b are unlike the only two factors of $b^2 - a^2$ are $a - b$ and $a + b$, neither of which can be zero, but when $b = a$ then $b^2 - a^2 = a^2 - a^2$, the only two factors of which are $a - a$ and a; the first of these two factors, $a - a$, being zero, the other factor a, may be repeated as often as we please without changing the value of the product.—Ed]

PROBLEMS.

83. BY GEO. L. DAKE, CLEVELAND, OHIO.—A point is given within two lines which form a given angle with one another. Required the shortest line which can be drawn through this point, terminated by the given lines.

84. BY PHILLIP HOGLAN, NEWCOMERSTOWN, OHIO.—The centres of two spheres whose radii are 12 ft. and 5 ft., respectively, are at opposite extremities of the diameter of a circle of 13 ft. radius. Find a point in the cirumference of this circle from which the greatest portion of spherical surface is visible.

85. BY PROF. JAMES G. CLARK, LIBERTY, MO. — In a quadrilateral there are given, the length and position of the lower base, the lengths of the two sides, the length of the upper base and the position of a point through which it passes: required to construct the quadrilateral.

86. BY PROF. J. S. HAYES, HODGENVILLE, KY.— Prove that the attraction of a sphere of uniform density upon an external point is the same as if all the matter of the sphere were concentrated at its centre.

87. BY G. M. DAY, LOCKPORT, N. Y.— There are n tickets in a bag numbered 1, 2, 3 . . . n. A man draws three tickets together at random and is to receive a number of shillings equal to the product of the numbers he draws. Find the value of his expectation.

88. **By Prof. H. T. J. Ludwick, Salisbury, N. C.**— An ellipse revolves about its latus rectum; show that the volumes of the solids generated by the larger and smaller segments are respectively equal to

$$\frac{4\pi a^3}{3}\left(1-e^2\right)\left[\frac{2+e^2}{2}+\frac{3e}{(1-e^2)^{\frac{1}{2}}}\tan^{-1}\left(\frac{1+e}{1-e}\right)^{\frac{1}{2}}\right], \qquad \text{and}$$

$$\frac{4\pi a^3}{3}\left(1-e^2\right)\left[\frac{2+e^2}{2}-\frac{3e}{(1-e^2)^{\frac{1}{2}}}\tan^{-1}\left(\frac{1-e}{1+e}\right)^{\frac{1}{2}}\right].$$

89. **By Artemas Martin, Erie, Pa.**—A sphere, radius r, *rolls* down the surface of another sphere of the same material, radius R, placed on a horizontal plane. The surfaces of both spheres and plane are rough enough to secure perfect rolling. Determine the motion of the spheres, the point of separation and the equation of the curve described by the center of the upper sphere.

90. **By R. J. Adcock, Monmouth, Ill.**— Let an oblate ellipsoid of revolution of homogeneous density rotate about one of its greatest diameters. What must be the ratio of its axes, that a column of liquid along the greatest diameter at right angles to the axis of rotation may just balance one along the shortest diameter? $a^2 \div \delta k_1$ being the same as in the case of the earth, where $a =$ angular velocity of rotation, $k_1 =$ attraction of a spherical unit of mass for another at the distance unity between centres, $\delta =$ mean density.

91. **By Prof. W. W. Johnson, Annapolis, md.**—Let a sphere, rotating with the angular velocity w, be provided with pivots at the extremities of a diameter inclined to the axis at the angle a. If these pivots be suddenly caught in fixed sockets, the sphere will rotate about the new axis with the rate $w \cos a$. If the pivots be caught by a ring which is itself free to rotate about an axis perpendicular to the new axis of the sphere and passing through its centre, the rate of rotation about this axis will be $w \sin a$. The original rotation and these component rotations represent kinetic energies which are proportional to w^2, $w^2 \cos^2 a$ and $w^2 \sin^2 a$: hence there is no loss of energy and no shock. That is, every particle will, when the pivots are caught, undergo no sudden change in velocity or direction. Prove the truth of this by spherical trigonometry.

Note. If solutions of the problems proposed in any No. are received by the 10th of the next succeeding month, they will in general be either published in the first succeeding No., or noticed at the head of "*Solutions of Problems*"; but if received after the 10th of such month, and if a solution of the problem, or problems, is published in the next No., no notice in general is given of such solution.—Ed.